Impact of maternal weight gain during pregnancy on expected fetal weight and neonatal birth weight:A prospective cohort study

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Abstract

Objective: To determine the impact of maternal weight gain during pregnancy on expected fetal weight and neonatal birth weight.

Subjects and methods: This prospective cohort study was conducted on 159 pregnant women; 53 women with normal weight as Group (A), along with 53 overweight pregnant women as a Group (B) and 53 obese pregnant women as a Group (C) according to BMI. The maternal weight gain was calculated and correlated to expected fetal weight and fetal birth weight. The study was approved by the Ethics Committee, and all patients gave their informed consent before inclusion in the study.

Results: We found that there was a statistically positive correlation between maternal weight gain, expected fetal weight and fetal birth weight in 3 study groups. maternal weight gain was significant independent predictor of fetal weight ($p \leq 0.001$), as maternal weight gain can predictor fetal weight in group (A) 38.4% , group (B) 46.2% and group (C) 42.6% .

Conclusion: The current study has demonstrated that pregnancy weight gain was associated with a significant effect on birth weight regardless of BMI. Additionally, maternal weight gain could be considered as a significant predictor of fetal weight.

Key words: Maternal weight gain, expected fetal weight, neonatal birth weight, pregnant women, cohort study.

Introduction

Maternal weight gain shows a wide variation, even in a low-riskpregnancy. Despite this, the importance of adequate gestational weight gain (GWG) is well documented.Maternal weight gain during pregnancy has a well-established influence on birth weight and infant health outcomes. For that, prenatal care guidelines emphasize the importance of overall maternal weight gain during pregnancy and its role in perinatal health [(1)].

Maternal weight gain is affected by many factors, including

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family, physiological, psychological, behavioral, cultural, social and environmental factors.The rate of maternal weight gain per trimester also depends on a number of maternal factors and can show wide variation throughout pregnancy[2].

Birth weight is cosidered a key predictor of survival and health of infants. Infants with low birth weights (less than 2,500 g) have increased risk of hypertension, type 2 diabetes and coronary artery disease in adult life, and those with birth weights more than 4000 g have an increased risk of intrauterine death (IUFD),hypoglycemia, hypertrophic cardiomyopathy, shoulder dystocia, meconium aspiration, and neonatal hyperbilirubinemia[3].

Maternal weight gain during pregnancy is associated with high birth weight and measures of adiposity early in life. Because high birth weight predicts body mass index later in life, these findings suggest that excessive weight gain during pregnancy could increase the long-term risk of obesity-related disorders in offspring. High birth weight might also rise the risk of other diseases later in life, includingatopy, asthma, and cancer [4].

Maternal nutritional status is believed to be a reliable predictor of adverse perinatal and long-term outcomes for both mother and infant. Being overweight or obese before becoming pregnant may represent high risk factor forfetal growth disorders [5].

Therefore, it is of particular relevance to study the effects of pre-pregnancy BMI and GWG on pregnancy and the newborn, and to develop a reasonable pregnancy weight control plan. In this study, we aimed to evaluate the impact of maternal weight gainduring pregnancy on expected fetal weight and neonatal birth weight.

Patients and methods

This prospective cohort study was conducted on 159 pregnant womenduring the period from July 2020 to November 2021 at outpatient clinic of our hospital; the institutional ethical review board approved the study.

Inclusion and exclusion criteria

Women who had singleton pregnancies aged 18–35years attended for antenatal care services in outpatient clinic of our hospital were included in this study. Whereas, women with pre-existing or current medical conditions, women with history of intrauterine growth restriction (IUGR), underweight women and women with multiple pregnancy were excluded from the study

Sample size:

Sample size of 53 women one group (at least) achieve 80% power with margin of equivalence range from (-5% to 5%) with significance level 0.05%.

After enrolment, the total sample size became 159 pregnant women divided into 3 groups as seen in figure (1):

- **Group (A):** pregnant women **(n=53)** who have normal weight.
- **Group (B):** pregnant women **(n=53)** who are overweight.
- **Group (C):** pregnant women **(n=53)** who have obesity.

Ethical consideration

Written informed consent was taken from the participants after they were informed about the purposes andobjectives of the study. Confidentiality and privacy were maintained throughout the study.

Maternal data:

- Measurement of maternal pre-pregnancy weight, at 32 weeks and at full term (>36wks). Then calculation of maternal weight gain during pregnancy.
- Age, height, BMI, parity were recorded.
- The BMI is classified according to the values determined by the World Health Organization (underweight <18.5 kg/ m2; normal weight, 18.5–24.9 kg/m^2;

overweight, 25–29.9 kg/m^2; and obese >30 kg/m^2).

Neonatal data:

- Measurement of expected fetal weight by ultrasound (by femur length and bi parietal diameter and abdominal circumference) at full term

Hadlock2:Log10 (weight) = 1.335 – (0.0034 X AC X FL) + (0.0316 X BPD) + (0.0457 X AC) + (0.1623 X FL).

- Measurement of actual neonatal birth weight.

Statistical analysis

Data were analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 21). The normality of data was first tested with one-sample Kolmogorov-Smirnov test. Qualitative data were described using number and percent. Association between categorical variables was tested using Chi-square test. Continuous variables were presented as mean ± SD (standard deviation) for normally distributed data .The three groups were compared with ANOVA test.Pearson correlation was used to correlate continuous variables. Significant variables entered into linear regression model to predict significant determinants and to control for possible interactions and confounding effects.The results were considered significant when p value $\leq$ 0.05.

Results

The demographic characteristics showed no statistically significant difference ($P \geq 0.05$) among three groupsas regard age, parity, pre-pregnancy body BMIof the 3 study groups are shown in table (1).

However, there was a statistically significant positive difference of the mean BMI ($P \leq$ 0.01), the maternal group (A) mean BMI was (22.21±2.01)as compare to maternal group (B) mean BMI of (27.22±1.52) and group (C) mean BMI of (33.75±2.57), as we compared between three groups according to pre pregnancy BMI.The three groups according to their BMI are (normal weight, overweight, and obese).

Our analysis revealed that there was a statistically significant difference in maternal weight between the three groups in different trimester. The mean of maternal pre-pregnancy weight (C) was 86.28±9.84, group (B) was 69.73±6.34, and group (A) was 57.83±6.96. The mean of maternal weight in 32 weeks, in-group (C) was 94.07±9.73, group (B) was 77.91±7.03, and group (A) was 66.11±7.41. The mean of maternal weight at full term in-group (C) was 99.24±10.43, group (B) was 83.06±7.18and group (A) was 70.55±7.67,as seen in table(2).

The maternal weight of group (C) pre-pregnancy, 32 weeks and at full term was higher compared to the other two groups ($p \leq 0.001$).

There was no statistically significant difference between the three groups at delivery ($P \geq 0.05$)as regard maternal weight gain. The mean of maternal weight gain in-group (A) was 12.72±2.57, in group (B) was 13.32±3.18 and in group (C) was 12.96±2.68

There was no statistically significant difference in Expected fetal weight ($P \geq 0.05$), and Fetal birth weight ($P \geq 0.05$) among three group (table). However, we found that the number of LGA was more in both overweight group (17%) and obese group (13.2%) compared to normal weight group (3.8%), as seen in table (3).

The number of normal birth weight was 46 (86.8%)in group (A), 40 (75.5%) in group (B), 43 (81.1%) in group (C) , and number of large for gestational age was 2 (3.8%) in group (A), 9 (17.0%) in group (B), 7 (13.2%) in group (C), however number of small for gestational age was 5 (9.4%) in group (A), 4 (7.5%) in group (B), 3 (5.7%) in group (C).

There was a statistically positive correlation between maternal weight gain, expected fetal weight and fetal weight at birth which means

the higher the maternal weight gain, the greater fetal birth weight, as seen in table(4), figure 2,3,4.

After linear regression analysis adjusting the confounding factors, maternal weight gain was significant independent predictor of fetal weight ($p \leq 0.001$), as maternal weight gain can predict fetal weight in group (A) 38.4%, group (B) 46.2% and group (C) 42.6%, as seen in table (5).

Table (1): Demographic data among studied groups.

Demographic data	Group (A) (n=53)	Group (B) (n=53)	Group (C) (n=53)	Test of significance	p value
Age (years) **Mean ± SD** **Min-Max**	24.34±4.77 17-36	25.51±5.52 18-42	26.60±4.46 18-40	F=2.78	0.065
Age class **≤25 y** **>25 y**	32 (60.4%) 21 (39.6%)	31 (58.5%) 22 (41.5%)	24 (45.3%) 29 (54.7%)	$\chi 2$=2.89	0.235
Parity **Nullpara** **P1** **P2** **P≥3**	19 (35.8%) 20 (37.7%) 10 (18.9%) 4 (7.5%)	17 (32.1%) 12 (22.6%) 14 (26.4%) 10 (18.9%)	15 (28.3%) 11 (20.8%) 13 (24.5%) 14 (26.4%)	$\chi 2$=9.99	0.127
Height **Mean ± SD**	161.13±6.12	160.89±5.56	159.79±6.11	F=0.766	0.467
BMI **Mean ± SD**	22.21±2.01	27.22±1.52	33.75±2.57	F=404	≤0.001*

F: ANOVA test, χ^2 : Chi square test.

Table (2): Maternal weight and maternal weight gain of studied groups.

Maternal weight	Group (A) (n=53)	Group (B) (n=53)	Group (C) (n=53)	Test of significance	p value
Maternal pre pregnancy weight	57.83±6.96	69.73±6.34	86.28±9.84	F=174.8	≤0.001*
Maternal weight in 32 weeks	66.11±7.41	77.91±7.03	94.07±9.73	F=157.3	≤0.001*
Maternal weight at full term (>36wks)	70.55±7.67	83.06±7.18	99.24±10.43	F=149.9	≤0.001*
Maternal weight gain	12.72±2.57	13.32±3.18	12.96±2.68	F=0.611	0.544

Table (3): Fetal weight among studied groups.

Fetal weight	Group (A) (n=53)	Group (B) (n=53)	Group (C) (n=53)	Test of significance	p value
Expected fetal weight	3095.37±479.48	3180.47±432.64	3190.3±482.52	F=0.667	0.515
Fetal birth weight	3167.54±452.52	3300.26±393.18	3322.45±456.64	F=1.965	0.144

NGA (N,%)	46 (86.8%)	40 (75.5%)	43 (81.1%)	$\chi 2$=5.25	0.262
LGA >4000 N,%)	2 (3.8%)	9 (17.0%)	7 (13.2%)		
SGA ≤2500 (N,%)	5 (9.4%)	4 (7.5%)	3 (5.7%)		

Table (4): Correlation between maternal weight gain and fetal weight.

Fetal weight	Maternal weight gain					
	Group (A)		Group (B)		Group (C)	
	r	p	r	p	r	p
Expected fetal weight	0.668	≤0.001*	0.655	≤0.001*	0.628	≤0.001*
Fetal birth weight	0.620	≤0.001*	0.680	≤0.001*	0.653	≤0.001*

r: Pearson correlation

Table (5): Linear regression analysis for maternal weight gain as a predictor of fetal weight.

	Constant	Unstandardized Coefficients		P value	95% confidence interval of B		R Square
		B	Std. Error		Lower ound	Upper bound	
Group (A)	1782.6	108.8	19.3	≤0.001	70.120	147.677	38.4%
Group (B)	2182.7	83.9	12.6	≤0.001	58.437	109.349	46.2%
Group (C)	1885.4	110.8	18.0	≤0.001	74.690	147.030	42.6%

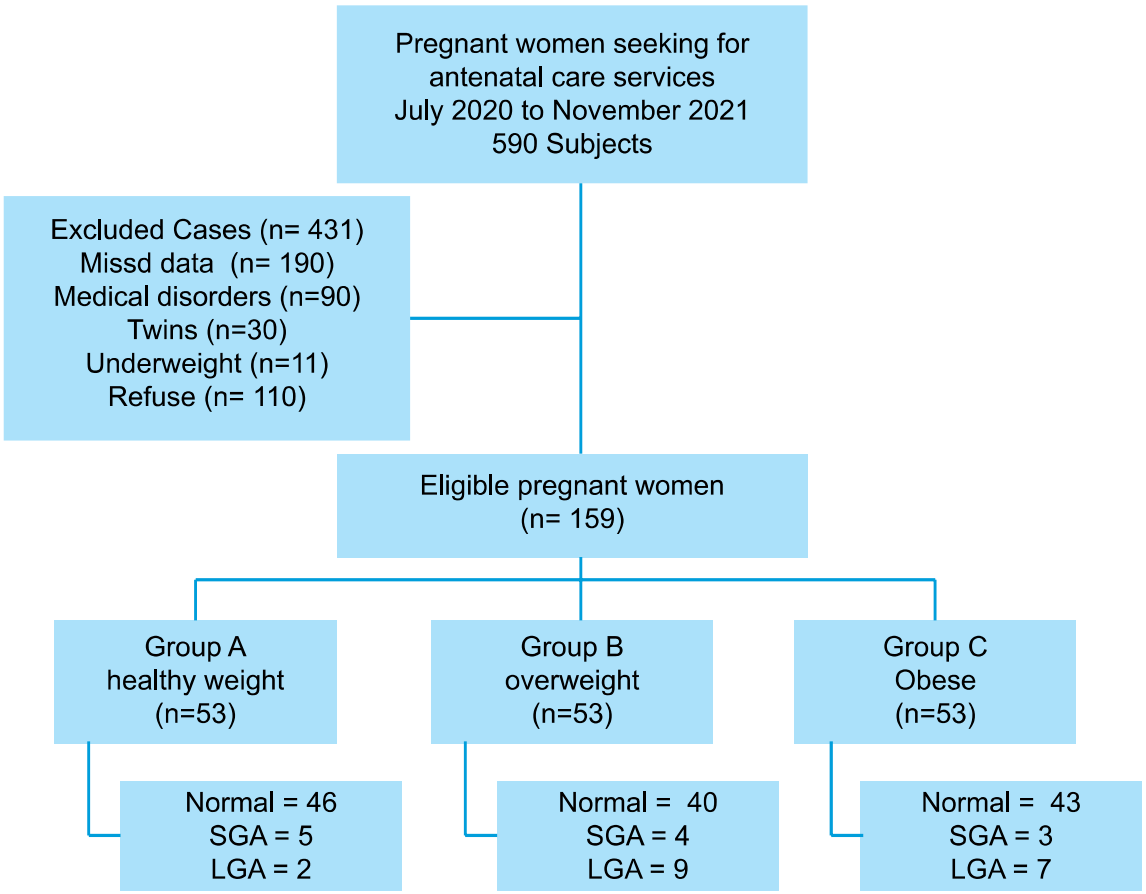

Figure (1): Flow chart of this study.

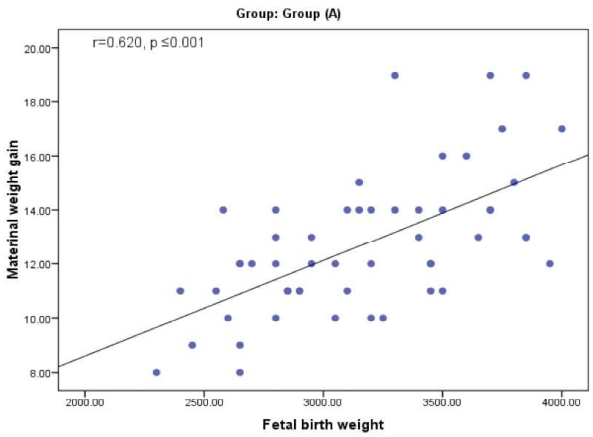

Figure (2): Scatter diagram for positive correlation between maternal weight gain and fetal birth weight in group (A).

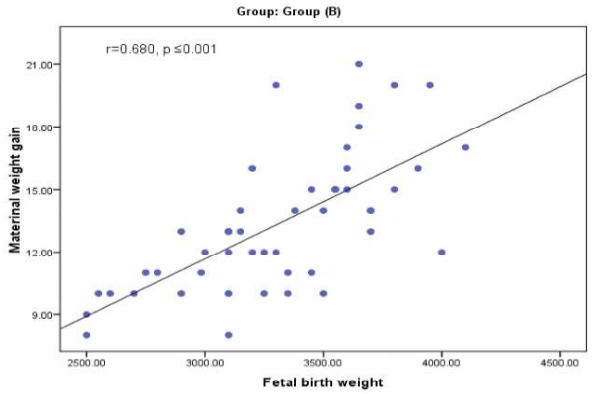

Figure (3): Scatter diagram for positive correlation between maternal weight gain and fetal birth weight in-group (B)

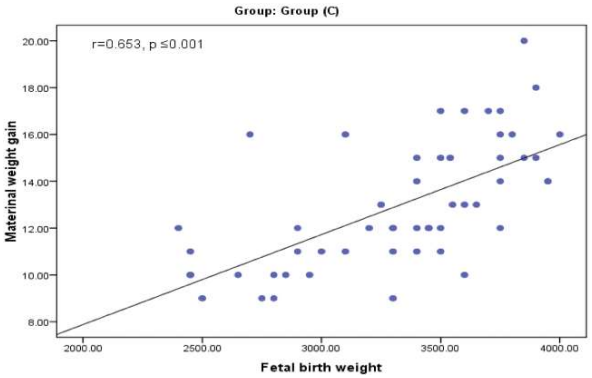

Figure (4): Scatter diagram for positive correlation between maternal weight gain and fetal birth weight in group (C)

Discussion

Maternal weight gain in pregnancy carries implications on both mother and child. Insufficient gestational weight gain has been linked to low birth weight and preterm birth, while excessive weight gain has been linked to infant macrosomia and maternal postpartum weight retention [6, 7].

This prospective cohort study was carried out on a total of 159 pregnant women aged 18–40 years to determine the impact of maternal weight gain during pregnancy on expected fetal weight and neonatal birth weight. Entire cases were further divided into three equal groups; group A which included pregnant women with normal weight, group B which included overweight pregnant women and group C which included obese pregnant women. There were no significant differences among the three studied groups regarding demographic features.

We found that there was a clear association between maternal obesity and infant size at birth. The findings were consistent with other research results [8,9,10,11].

We found that the number of LGA was more in both overweight group (17%) and obese group (13.2%) compared to normal weight group (3.8%). Similar to our results, Sun et al study strongly detected that being overweight and obese, and more gestational weight gain were important risk factors for LGA compared to pregnant women with normal BMI (5). Obesity and unacceptable weight gain during pregnancy may lead to increased concentrations of glucose, amino acids and free fatty acids in pregnant women, thereby increasing the risk of abnormal infant weight at birth [12].

This study revealed that there was a statistically positive correlation between maternal weight gain, expected fetal weight and fetal weight at birth which means the higher the maternal weight gain, the greater fetal birth weight in the context of the three studied groups separately.

In the study of Mamun et al, dedicated that excessive weight gain during pregnancy is associated with greater birth weight in the babies [13]. On the other hand, Tsai et al, found that a low birth weight was greatly associated with low weight gain (<10 kg) [14]. Tela et al, also declared that the pregnancy weight gain has a significant effect on birth weight [1].

Likewise, several studies declared that the mean BW in pregnant mothers with higher gestational weight gain was significantly greater than the mean BW in those with a lower weight gain [15, 16, 17].

These findings suggested that women can minimize their risk of neonatal morbidity and mortality by adjusting their weight prior to conception and gaining the recommended weight amount throughout the pregnancy [15].

Finally, after linear regression analysis adjusting the confounding factors, we found that the maternal weight gain was a significant independent predictor of fetal weight ($p \leq 0.001$), as maternal weight gain can predict fetal weight in group (A) 38.4%, group (B) 46.2% and group (C) 42.6%. Our results were similar to those reported by Sommer et al, who had detected that gestational weight gain is the strongest independent predictor of BW [17]. In harmony with the current study, Tela et al have reported that the pre-pregnancy BMI and GWG were statistically significant independent predictors of BW [1].

In the same line, Meinich and Trovik had displayed that; not regaining pre-pregnancy weight by week 13–18 was an independent predictor of inadequate total gestational weight gain and an independent predictor for SGA outcome, even when total pregnancy weight gain , pre-pregnancy BMI, parity, age and smoking status were adjusted [18]).

Several limitations in this study should be taken into consideration. First, the sample size may still not be large enough for stratification. Second, the pre-pregnancy weight and height were actually the weight and height may be measured during the initial prenatal examination and may therefore be biased. Third, the enrolled subjects reflect only a single Governorate, not reflect a lot of geographical regions. Moreover, there could be possible association between birth weight and other factors such as physiological, psychological, socio-cultural, and environmental factors

It is of great importance to pay attention to pre-pregnancy BMIs and GWGs to ensure adequate birth weights of newborns. Further studies have to be conducted on larger number of populations. Pregnancy weight management should be actively promoted through intensive counseling during the routine ANC contacts.

Conclusion

The current study has demonstrated that pregnancy weight gain was associated with a significant effect on birth weight regardless of BMI. Additionally, maternal weight gain could be considered as a significant predictor of fetal weight.

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Legends to tables:
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Table (2): Maternal weight and maternal weight gain of studied groups.
Table (3): Fetal weight among studied groups.
Table (4): Correlation between maternal weight gain and fetal weight.
Table (5): Linear regression analysis for maternal weight gain as a predictor of fetal weight.

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Figure (3): Scatter diagram for positive correlation between maternal weight gain and fetal birth weight in-group (B).
Figure (4): Scatter diagram for positive correlation between maternal weight gain and fetal birth weight in group (C).

List of abbreviation:
AC: Abdominal circumference
BMI: Body mass index.
BPD: Bi parietal diameter
FL: Femur length
GWG: Gestational weight gain.
IUFD: Intrauterine death.
IUGR: Intrauterine growth restriction.
LGA: Large gestational age.
NGA: Normal gestational age.
SD: Standard deviation.
SGA: Small gestational age.
SPSS: Statistical Package of Social Science.